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1978 Research Accomplishments

# Learning About Forests



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United States Department of Agriculture  
Forest Service  
General Technical Report WO-11







# **1978 Research Accomplishments LEARNING ABOUT FORESTS**




## FOREWORD

One of the Forest Service's major responsibilities is to learn more and more about forests and wildlands—how to manage them and how to use them. To get the most from our forests, whether in terms of wood, wildlife, water, or wilderness, we need to continually increase our knowledge and refine our practices. We pursue these goals at eight forest and range experiment stations, strategically located throughout the country, plus a forest products laboratory. Much work is also done cooperatively with universities and other research organizations.

Highlighted here are about 40 items that show the kinds and diversity of research in progress at these facilities. Some of them merely report the progress of ongoing projects; others depict research completed and results already in use.

Many research results come in small pieces rather than large packages. Some of these pieces, although ultimately intended to fit into larger packages to help solve broad problems, are interesting and useful in themselves. And so we publish them for whatever interim benefits they may offer.

The highlights featured in the following pages are just a sampler of course, but for whetted appetites there is more. Listed at the back of this book, beginning on page 43, are all the publications issued by our entire research staff during fiscal year 1978. This list gives a picture of the variety and complexity of the problems that confront us when we set out to "manage" forest land. The list is categorized by subject to make it easier to search out a favorite topic. For further information, please contact the appropriate research headquarters directly. Their addresses are on the inside back cover.

A handwritten signature in dark ink, reading "John R. McGuire". The signature is written in a cursive, flowing style.

JOHN R. MCGUIRE  
Chief



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## Turning Waste Into Wood

Scientists from the North Central Station are learning how to use a tree instead of a treatment in disposing of municipal sewage. They are letting Michigan's forests recycle city wastes into fiber and foliage.

In northern lower Michigan near Cadillac, researchers are spraying forest land with environmentally safe dosages of sewage sludge that fertilizes trees without releasing too many nutrients to the groundwater supply. The study has found that cost to the city is no greater than with conventional treatment methods.

Two other rural communities in the Lower Peninsula are using land treatment to dispose of their sewage effluent by irrigating and fertilizing trees.

In studies near Harbor Springs and near Middleville, researchers are examining two questions: Can the trees grow with large amounts of effluent? Can they remove the nitrogen, phosphorus, and other nutrients from the sewage? Preliminary results look promising for other communities that choose land disposal systems over treatment plants.

As the treated trees grow on these forest and cutover lands, researchers will evaluate the longrun effects of sewage effluent and sludge on water quality, timber production, and energy use.







## Sanitation in the Back Country

Disposal of human waste is one of the most critical problems for back country managers. The problem is compounded because many campsites are located at high elevations where the soil is shallow and because use has increased so much that 10 to 20 visitors per night may use the same facilities.

Frequent relocation of latrines is a short-term solution at best. A standard latrine requires a hole at least 4 feet deep and hence the number of possible sites is limited.

Researchers at the Northeastern Station have done much to solve this problem by using waste composting methods. A simple bin was developed to compost human wastes mixed with ground bark. The decomposition process takes about 2 weeks in the closed container and the compost pile reaches temperatures above 60° C. The bin can be maintained easily by regular field crews and the end product is a humus-like substance, environmentally safe and odor free. Because the process is contained in the bin, soil depth is no longer a problem. Cost of a unit is about \$100. One such bin can process the waste of more than 1,500 people per year at a total cost of about \$250.



## Water Quality in the Northern Rocky Mountains

What happens to water in the mountains affects its use on the plains. So the place to begin protecting our water supply is at its source. Congress recognized this in 1972 when it amended the Federal Water Pollution Control Act to require that pollution control "... be planned and managed through an integrated, areawide, wastewater treatment plan." This direction posed a problem in the northern Rocky Mountains, where little is known about basic water quality relations.

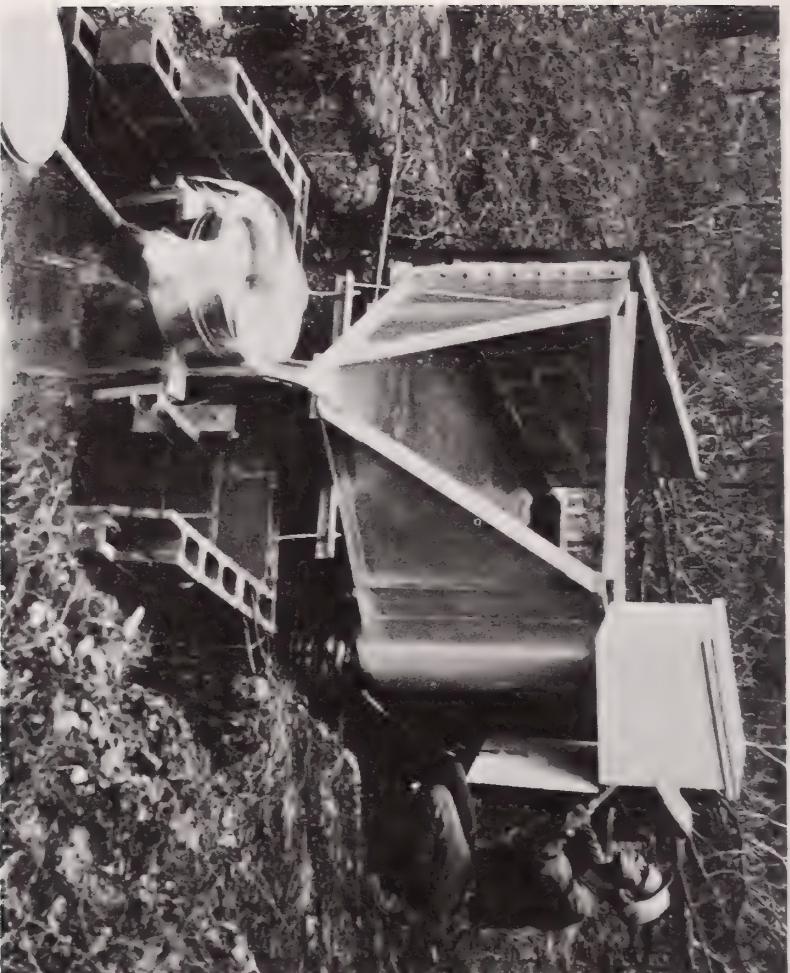
To help meet the mandate, the Intermountain Station and the Environmental Protection Agency began to investigate the quality relations of water that originates in the forests of the northern Rockies. Researchers established study areas in river basins near Glacier, Yellowstone, and Grand Teton National Parks. Streamflow, suspended sediment, and dissolved elements were analyzed and correlated with watershed geology and other physiographic characteristics.

The researchers developed water quality rating curves and other predictive relations between basic geology and water quality. The Environmental Protection Agency and local planners now use this information in the planning process.

The information was also used to develop a model—the Water Quality Benchmark System—now being adopted by the Northern Region of the Forest Service. The system shows high potential for helping integrate water quality considerations into land management planning.







## How Much Pollution Is “Normal” for Forest Water?

To establish water quality standards for forest land, we need to know how much water pollution is “normal.” Otherwise, standards may be so strict that conducting forestry operations would be impossible.

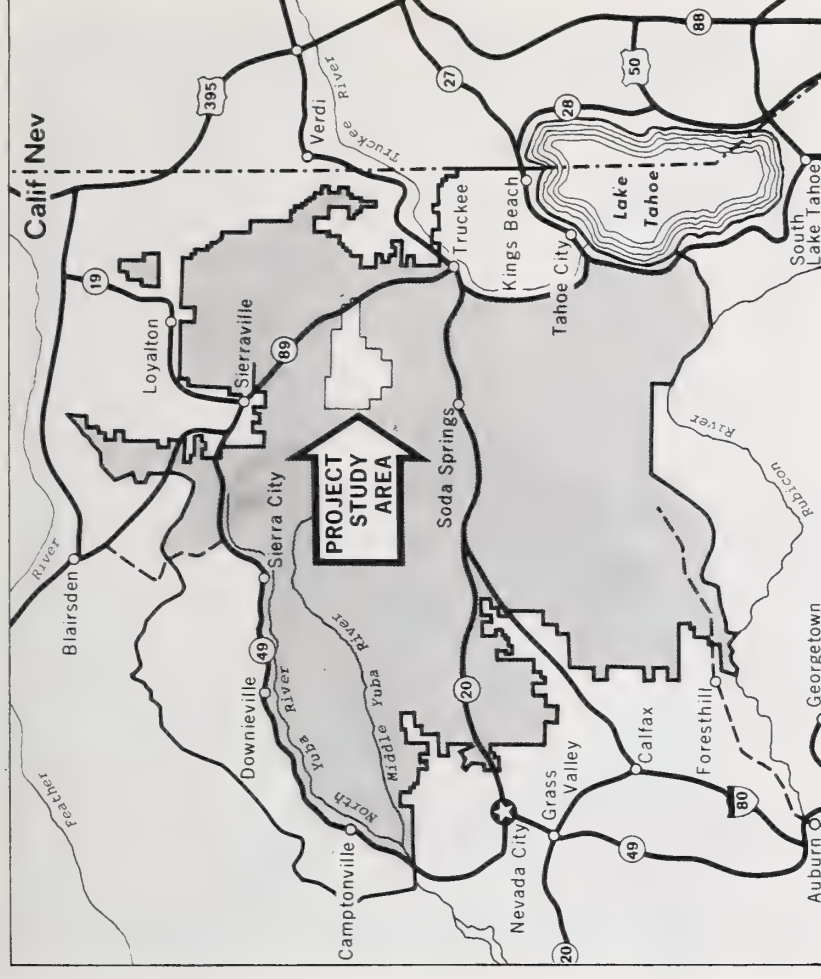
For example, Southern Station scientists have examined water from undisturbed pine-forested watersheds and found that the level of phosphorus in solution is near that suggested by the EPA as the maximum allowable. Phosphorus in suspended sediment accounted for two-thirds of the total annual phosphorus yield. This finding emphasizes the importance of minimizing sediment yield to protect water quality.

So far, scientists have determined that sediment concentrations average about 0.007 tons per acre-inch of flow from planted loblolly pine and mature natural shortleaf pine-hardwood stands in the upper Coastal Plain of Mississippi. Concentrations from individual storms may be 10 times or more higher, due largely to flushing of sediment accumulated in channels—a phenomenon that may be unrelated to forestry operations. Recently, the Southern Station, universities, and forest industry began a project to find base levels of pollution for other geographic areas of the Coastal Plain.

## A New Approach to Environmental Assessment

Researchers at the Pacific Southwest Station have developed a new computer-assisted system that will aid forest and range managers with the difficult task of assessing the impact of various land treatments on the environment. Called IMPACT, the system consists of (1) an information base built around a complex network of social, economic, and natural environmental conditions linked together in cause-and-effect relations commonly associated with management activities; and (2) a computer program that resource managers and specialists can use to search this information base. It combines the speed, memory, and thoroughness of the computer with the professional skills, local knowledge, and judgment of the user in assessing environmental impact in land-use planning.

In its development stages, IMPACT was tested on actual land-use problems on the Tahoe National Forest in California and in a six-State area in the Rocky Mountains and Great Plains. It is currently being used by planning units in both the Forest Service and the Bureau of Land Management throughout the United States.







## Environmental Effects of Weather Modification

Weather modification, generally cloud seeding, is being used in California and other Western States to increase water supplies. Its widespread use has been hindered, however, because little is known about the environmental effects of increasing or extending the snowpack.

Because it is difficult or impossible to measure the ecological effects of weather modification by conventional monitoring methods, scientists at the Pacific Southwest Station analyzed long-term records of precipitation, temperature, and snowpack and developed simulations for various aspects, covers, and climatic regimes. The simulations were used as a basis for evaluating the impact of weather modification.

The analyses and evaluations showed that, although weather modification can increase long-term average precipitation 10 to 15 percent, the increase is not expected to cause significant ecological changes. The work also resulted in a method for scheduling and monitoring early season cloud seeding to prevent development of abnormally large snowpacks in unusually wet years.

# Snow Control Research Yields Useful By-Product

Sometimes research produces fringe benefits far afield from its original intent. Here are a couple of examples from the Rocky Mountain Station's snow control project.

Blowing snow often makes winter driving hazardous over most of the northern United States. Forest Service scientists in Wyoming and Colorado, however, have engineered systems to take much of the sting out of blowing snow in critical areas.

Scientifically designed and placed snow fences up to 12 feet tall are highly effective for trapping snow in drifts away from highways, improving visibility, and reducing road ice. A \$2-million, 21-mile snow fence system designed by the Forest Service for the Wyoming Highway Department has reduced accidents up to 50 percent and highway closure time up to 80 percent along a drift-prone stretch on Interstate Highway 80. A similar system is being constructed to protect Alaska's North Slope oil pipelines.

The Wyoming Highway Department also uses a computerized Forest Service "drift profile prediction model" for earthwork design, so that highways can be engineered to be drift-free.

These applications of snow control research, originally intended for avalanche control and water yield in the high Rockies, will significantly reduce highway snow removal costs, help conserve fuel, prevent deterioration of pavement caused by moisture penetration, and increase highway safety.

Related research led to an instrument for measuring visibility in blowing snow. Station scientists applied recent discoveries in snow transport physics when designing a computerized system to analyze and interpret these data, make traffic operation decisions, and advise motorists by means of variable-message signs. The system is being used on I-80 in Wyoming.







## Intensive Management Pays Off for California Deer Herd

Like deer throughout California, the North Kings herd of the central Sierra Nevada has steadily declined in recent years—down from an estimated 17,000 in 1954 to a low of about 3,500. However, as a result of an intensive cooperative research and management program, a concept of total management is being developed and implemented for this herd in an effort to restore its numbers.

Under the integrated program, cosponsored by the Pacific Southwest Station and a diverse group including a sportsmen club and State and Federal agencies, the type and proportion of needed forage have been determined, new forage species have been introduced, and fertilization trials have improved quantity and nutrition of herbaceous vegetation.

More than 10,000 acres of deer range have been treated in some 30 different management projects, ranging from seeding to prescribed burning. Some of the treatments so enhanced vegetation that deer use increased five-fold. In one prescribed burning treatment, mountain whitehorn, a favored browse species, increased from 28 to 560 plants per acre, and the range is continuing to improve.

The techniques for improving habitat have been coordinated with timber harvesting, watershed management, and fire management. While all the answers are not yet known, the herd is expanding.

So far, the coordinated management techniques have resulted in improved habitat, increased browse with higher nutritional values at critical stages, total increase in the herd, improved age distribution, and increased fawn survival.



## Ask "RUN WILD" for Information About Wildlife Needs

How does harvesting forest trees, building a dam, or establishing a recreation area affect wildlife? Research has developed many bits and pieces of valuable information about individual species, but frequently managers have difficulty assembling these fragments to solve specific problems.

To help managers collect such information, Rocky Mountain Station wildlife researchers designed a computerized information storage and retrieval system. Called "RUN WILD," the system contains information on wildlife species distribution, protection status, and key food and cover requirements.

The system can provide three types of information. First, RUN WILD provides basic information, such as lists of mammals, birds, fish, reptiles, or amphibians in an area. It can also provide more detailed information about specific food or cover requirements of individual species. Finally, the manager can ask RUN WILD for specific management information and literature references for particular species likely to be affected by his actions.

Current documentation for the Southwest consists of over 3,000 references on 324 birds, 159 mammals, 105 fish, 105 reptiles, and 27 amphibians. The system is now being readied for adoption in other parts of the country.





## Wildlife and Timber: Peaceful Coexistence

Forests managed primarily for timber can also sustain much wildlife, but only if the animals are favored by timber management prescriptions. For example:

- Trees grown in open stands have well-developed crowns and produce more fruit than trees grown in dense stands.
- Understory plants growing in light to moderate shade begin fruiting younger and produce fruit more consistently than plants in deep shade.
- Tree age affects productivity: Trees in the middle of their lifespan produce more fruit than either young or old trees.
- Prescribed burning increases fruit production of many understory species but may destroy other species or seriously reduce their capacity to produce fruit.
- Genetically superior trees may grow 20 or 30 percent faster than unimproved trees, and it is likely that fruit production can be increased correspondingly.

The variety of fruits is as important to wildlife as the abundance. When many kinds of plants are present, fruits are likely to be available year-round, stands will produce fruits consistently year after year, and the habitat will meet the needs of many wildlife species. A variety of fruit also offers animals a balanced diet, especially in the South, where many forages are deficient in nutrients during several months of the year.

A recent publication of the Southern Station describes and illustrates 106 woody plant species that produce fruit useful to wildlife in southern forests. More important, it gives information about plant growth requirements, management, and nutritional quality. Trees, shrubs, and vines that produce fleshy fruit or nuts are emphasized because their fruits are a vital source of food for many animals and birds.



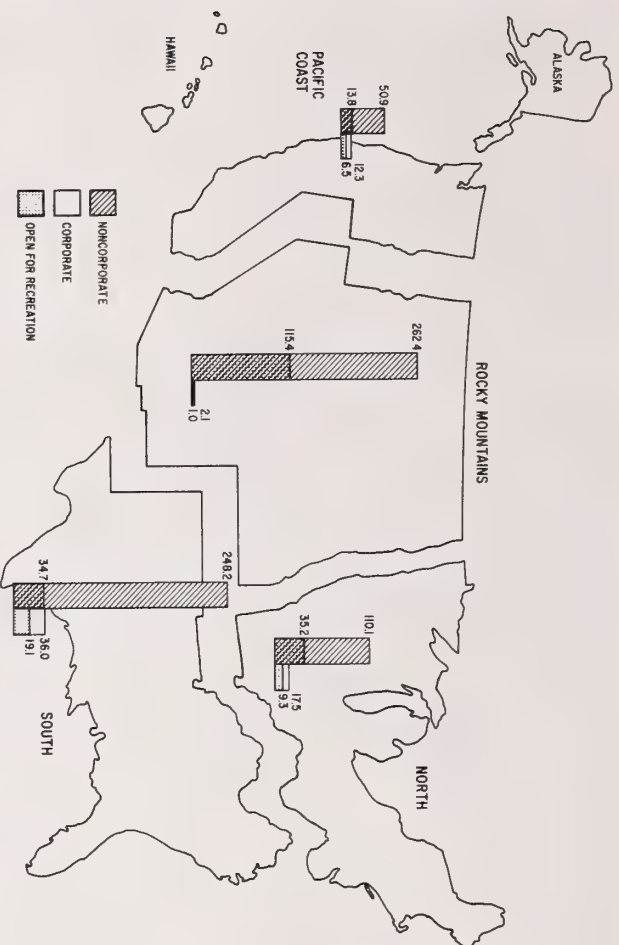
## Stomach Pump for Fish

In the past, a fish had to be killed before the contents of its stomach could be examined. And because what fish eat is important to fisheries experts, as well as to fishermen, extensive research projects were wasteful—not to mention being hard on fish. So an Oregon State University researcher developed a technique for sampling the stomach contents of young fish without harming the fish. The method has been thoroughly tested by Forest Service scientists and found to be effective.

The system is much like having your stomach pumped out. A blunt, hollow needle is inserted through the mouth of the fish and into its stomach. Water is forced gently into the stomach and the contents are flushed back into a collecting jar. Thus relieved of its latest meal, the fish swims away unharmed. And the researchers have their sample.

During the past 3 years, Forest Service researchers tested the technique on three salmonids—coho salmon, cutthroat trout, and rainbow (steelhead) trout—and found it to be quite harmless to fish.





Acreage of privately owned forest and range land and amount open to public recreation.

## Private Land for Public Recreation

What part does—and could—private land play in providing facilities for public recreation? The question is important in view of the increasing demand for recreational sites and the large amount of privately owned forest and range land.

The Southeastern Station conducted a nationwide survey of forest and range landowners to determine the amount of private land that is open to public recreation and the attitudes of landowners toward such use.

More than half the corporate forest and range land in the United States is open to public recreation, and almost one-third of that owned by individuals and families is similarly open. A major reason given by corporations for allowing public use is to improve public relations. Many noncorporate owners cited difficulties in posting their land. Many of those who allow public recreation encounter problems such as littering, garbage dumping, fire, vandalism, crop damage, equipment theft, illegal hunting or fishing, and intrusions on owner privacy.

More than half the owners of closed land said that they would not allow public recreation under any circumstances. However, others said that reasonable profit, protection from lawsuits, and tax incentives would induce them to change their minds.

The survey concludes that a large amount of private land is available for public recreation. East of the Mississippi River, this acreage far exceeds that of public land.



## Who Skis—and Why

Skiing popularity has snowballed throughout the country during the past decade. Although the economics of the skier market has been evaluated locally, no nationwide survey of this growing business was made until recently when a cooperative study was conducted by the Northeastern Station, the Washington Office Resource Program and Assessment staff, and Cornell University.

This first comprehensive look at what has become a major outdoor recreation market included regional descriptions of present skiers, former skiers, and people who plan to take up skiing in the future. A telephone survey provided data from 2,191 potential, active, and inactive skiers.

The study also provides detailed information on the public attitudes towards skiing, its costs, attractions, facilities, and market needs. Planners and developers of skiing facilities now have an objective estimate of the skier market's potential for short-term growth, both regionally and nationally. They will also be able to assess the adequacy of current skiing facilities.







## Following the Nutrient Cycle

Most of the benefits a forest provides depend upon the productivity of the soil. So, if a forest soil is being depleted, land managers need to know it and to change their ways before the production of benefits starts to decline. Studies of nutrient cycling are designed to provide the necessary early warnings about soil depletion. Much of the research on nutrient cycling in forests is being done by the Northeastern Station in cooperation with Yale and Cornell Universities and by the Southeastern Station in cooperation with the University of Georgia.

The studies are conducted on watersheds that have been instrumented to measure the amount of water leaving and its mineral content. Over long periods, the effects of various forest management practices on water production and quality have been measured. Now, the effects of management practices on mineral cycling are being measured on the same watersheds.

Of particular interest currently is the increased drain caused by whole-tree logging—the harvest of stumps, small limbs, and leaves along with main stems. Loggers have traditionally left such materials in the woods, and the nutrients in them have returned to the soil. We need to know how seriously whole-tree logging will upset this cycle, hence the intensified research effort.



## Immigrant Pine Proves Blight Resistant

Austrian pine has long been used for landscape planting and, because of its hardiness and growth form, in shelterbelts to protect people, crops, soils, and wildlife from the harsh environment of the Great Plains. However, a devastating needle blight, caused by the fungus *Dothistroma pini*, kills many trees.

In an effort to discover faster growing, disease resistant strains of Austrian pine, Rocky Mountain Station scientists in eastern Nebraska established plantations in 1962 from seeds collected in Europe throughout the natural range of the species.

Although many sources produced some trees highly resistant to *Dothistroma* blight, a Yugoslavian source was consistently better than others—much better than sources traditionally used to grow seedlings for distribution in the United States.

Young trees from the Yugoslavian seed source are now being mass-produced in “seed orchards” for wide-spread planting in shelterbelts and urban areas.







Before and after sediment removal.



## Research Contributes to Land-Use Plan

Based primarily on the strength of research results, timber harvesting will resume on the slopes of the South Fork of the Salmon River. A long-term research program in the Idaho "Batholith" (an area characterized by steep slopes and highly erodible soils) contributed directly to a Boise National Forest land-use plan. The plan calls for an average annual timber cut of nearly 8 million board feet for 5 years, followed by an increase to about 12 million board feet per year. The timber cut will depend on continued favorable fishery conditions in the river.

The South Fork of the Salmon, a key spawning stream for anadromous fish, is typical of the Idaho Batholith. Intensive logging and road construction followed by severe storms (in 1964 and 1965) caused extreme sediment deposition that filled resting pools and buried many fish spawning beds. So the Forest Service declared a moratorium on all timber sales and road construction in the South Fork.

The Intermountain Station then accelerated research to help improve conditions in the South Fork and to provide for better management of all Batholith land. Studies over a 15-year period determined erosion and sediment impacts of logging and road construction and developed erosion control practices. Guided by these results, scientists worked closely with National Forest personnel to develop a land-use plan for the South Fork. The research used in developing the South Fork plan is also being applied in other National Forests in Idaho.



## Preventing Fires Where City and Wildland Meet

In southern California, one of the worst fire hazards occurs where cities and towns encroach on forests, chaparral, and brushland. Wildland fires have increased five-fold in southern California in the past 10 years, and one out of five start where city and wildland meet.

Because of the explosive nature of these fires, preventing them is a lot surer than trying to suppress them once they start. So, the Pacific Southwest Station is coordinating the research for a unique cooperative effort to analyze the fire problem, and to design, evaluate, and implement cooperative prevention programs in such locations. Cooperators include: the National Fire Prevention and Control Administration, and the Bureau of Census, U.S. Department of Commerce; the California State Department of Forestry; the University of California at Riverside; the city and county of San Bernardino; and the San Bernardino National Forest.

Station researchers have developed "spatial risk maps" that pinpoint the mathematical probability that a fire will start in a given place at a given time for each 40-acre compartment in a 110,000-acre study area, extending from the city of San Bernardino through the San Bernardino National Forest to the high desert country to the east.

The researchers have also modified Census Bureau computer programs to provide a standardized data base for all important fire and fire prevention information for National Forest, State, county, and city land. This is the first time census information has been used for this purpose.

The cooperative project is the first of its kind in the United States and is already serving as a model for other communities where urban growth is bringing the wildfire problem closer to the city.





## Better Use of Fire Retardants

Air tankers loaded with fire-retardant chemicals are the key to fast, efficient forest and range fire control. Fire control agencies in the United States use about 29 million gallons of retardants each year in air tanker operations. Retardant costs exceed \$5 million a year and their delivery and application add another \$20 million to the bill.

Significant savings can be realized by increasing retardant chemical effectiveness, improving methods of delivery and application, and refining strategy and tactics. At the same time, detrimental impacts on the environment resulting from retardant drops must be minimized.

Researchers at the Intermountain Station strive to provide fire managers with systems and guidelines to improve the performance of air tanker operations. Consideration is given to the effectiveness, physical properties, delivery systems, and environmental impact of fire retardants. A computer model has been developed that helps assess the fire control value of various retardant characteristics. Field tests measure retardant distribution and concentration at different heights and speeds. An experimental tank system (designed for the study) tests release of the retardants.

Research efforts have produced air tanker guidelines for use in selecting the specific air tanker most effective for local fire-fuel situations. The guides also enable the managers to evaluate the performance of individual tankers. In addition, the researchers have devised methods to prevent corrosion in retardant mixing and delivery systems.





## Protecting Seed Orchards From Insects

More and more tree plantations are being established from genetically improved seed produced in seed orchards. Like all "farm" crops, pine seeds have enemies, particularly insects.

So, like the farmer, a seed orchard manager must find ways to protect his crop, while producing a minimum of environmental side effects. Forest Service entomologists have developed a procedure called **cone analysis** to help.

A few years ago, production in some southern pine seed orchards was so low that the Southeastern Station was asked to find the cause and develop a cure. Several species of insects were identified as the culprits, and insecticide treatments were developed to control them. But all of the troublesome insects are not present in all seed orchards. To decide whether treatment is necessary, the orchard manager needs to know what insects are attacking and how much damage they are causing. Without this information, he must protect against all insects, including the ones that are not there.

Systematic analysis of cones and seeds provides the needed information. Details about the procedure are contained in a recent Southeastern Station publication. By following the recommendations, a manager can evaluate his orchard and decide what insecticide treatments are necessary.







### **Western Forest Insect Book Published**

A newly published reference book will help practicing foresters recognize forest insects and the damage they cause. Nearly 1,400 species of insects and related organisms are described in the 654-page book, *Western Forest Insects*, USDA Miscellaneous Publication No. 1339.

Described are insects found on trees, shrubs, and wood products in North America west of the 100th meridian and north of Mexico. Most of these species are harmless or innocuous. But 31 are considered major pests, and a number of others are occasional pests. The book has two primary indexes and background chapters on the role, natural regulation, habitat relations, and control of insects.



## Guide for Managing Sycamore Pests

Throughout the South, sycamores are important in natural stands and are often cultured in plantations. They also are widely planted as attractive, fast-growing ornamentals. But insects, diseases, and pollutants take a heavy toll of sycamores. Although these pests kill few trees, they reduce growth, mar the beauty of the trees, and degrade lumber.

Researchers at the Southern Station and pest management specialists of the Southeastern Area, State and Private Forestry, have assembled a booklet of the latest information on 31 species of insects and diseases and 4 air pollutants that commonly damage sycamores. The 36-page, color-illustrated publication includes guides for identifying the pests and the damage they inflict. It gives preventive measures, cultural practices, EPA-registered chemicals, and harvesting techniques that can be used for control. Particular attention is paid to natural enemies that can help control outbreaks of insects.







## **Breeding for Rust Resistance**

Fusiform rust is the most serious disease in southern forests. It attacks young pines, particularly those in plantations, and the only promising method for controlling the disease is by breeding resistant trees. Recent findings at the Southeastern Station indicate that this breeding will be a continuing task, as it is with grains.

Plant breeders are constantly developing new strains of wheat to keep ahead of wheat rust. They must do so because the fungus is highly variable and develops the ability to infect previously resistant strains. It appears that the same sorts of programs will be required to control fusiform rust in forest plantations.

Many studies have demonstrated that loblolly pines, the most popular trees for reforestation in the South, vary widely in their resistance to fusiform rust infection. Some of the most resistant trees have been cross-pollinated, and their progeny are being included in tree breeding programs. A recent study shows, however, that different strains of the rust fungus vary widely in their ability to infect loblolly pines. Even the most resistant pines are highly susceptible to infection by some forms of the rust.

According to pathologists who did the research, the findings are neither surprising nor depressing. Although breeding for resistance on a one-time basis would have been convenient, the technology for locating resistant pines and crossing them with trees containing other desirable traits has been developed.



## Quick Action Saves Money—and Elms

Researchers at the Northeastern Station have shown that losses of trees to Dutch elm disease can be reduced by early identification and removal of diseased trees. This is good news for municipal arborists in particular, and for city and town dwellers in general.

In a recent trial, disease surveys during the summer months were tripled in parts of the Northeast. The affected trees were removed within 20 working days after detection of the disease, instead of waiting to remove them during the fall and winter months. This intensified effort reduced the incidence of Dutch elm disease by 1.2 percent the first year, 2.4 percent the second year, and 6.7 percent the third year.

Cost of this program was twice that of the conventional survey program, but tree removal cost was only three-fourths that for the usual treatment. So the net result over a 3-year period was a dollar savings to the taxpayers of about 25 percent. More importantly perhaps, the program saved an additional 92 trees per thousand in the elm population to maintain the beauty of the neighborhoods.







## **Solar Power for Drying Wood**

The sun provides energy for growing plants, heating homes, and now, for drying lumber.

Harnessing the sun's power, scientists from two Forest Service research units have designed solar wood dryers at promising savings in cost and energy use. Because drying consumes 60–70 percent of the energy required for manufacturing lumber, using the sun can greatly reduce the need for fossil fuels.

Researchers of the North Central Station have built a solar dry kiln, using recycled beverage cans in the solar collector. They found that solar drying takes half the time and produces better quality lumber than does conventional air drying.

Scientists from the Forest Products Laboratory have developed a low-cost solar kiln for tropical countries such as the Philippines. Their kiln costs less than \$6,000 and can dry 4,000 board feet a month. Built into the ground, the kiln's solar collector is separate from the heavily insulated drying chamber. This unique design permits a larger collector for less cost.

# Wood Products From Wood Fuels

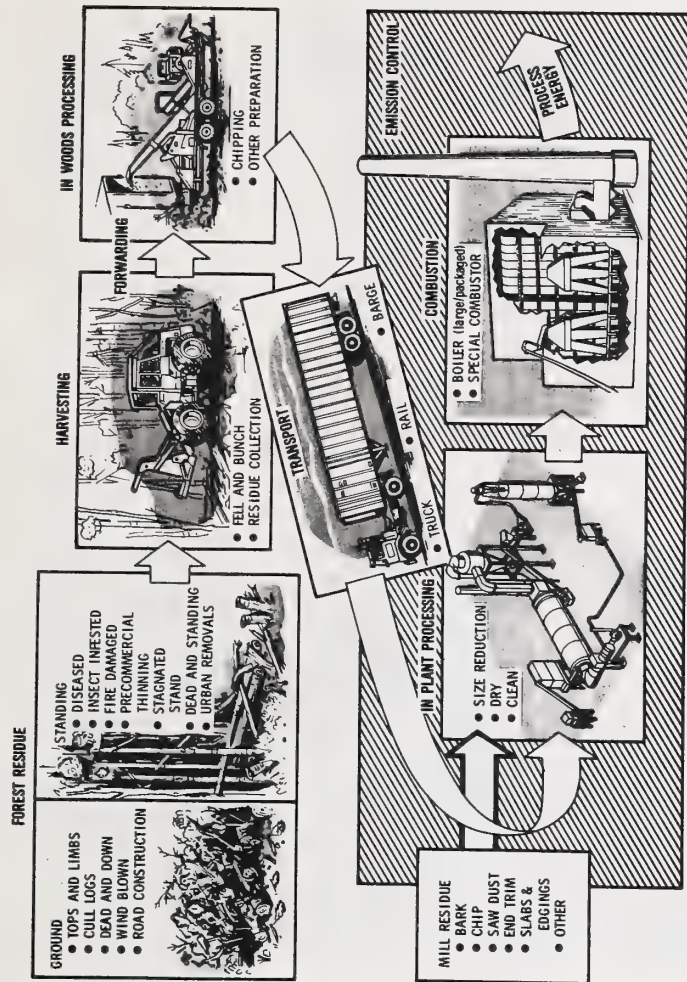
Picture this: On the northern shore of Lake Michigan, a mill produces paper each day, its energy needs supplied by wood wastes from logging and manufacturing and from rough and rotten trees, tops, and limbs. The mill no longer needs the coal, oil, or gas that once fired its boilers and kilns; it now uses wood residues exclusively for fuel.

Pie-in-the-sky theory? A forester's dream? No—the above scene could be real in just a few years.

North Central Station scientists studied the pulp and paper industry in Michigan's Upper Peninsula and in northern Wisconsin to see if use of wood residues could make energy independence possible. They found that 9 out of the 10 major mills within the area could become energy self-sufficient with forest-residue fuels in the 1980's.

Although pulp and paper mills already burn some wood for fuel, they must now buy most of the energy they need. The mills consume a big chunk of the energy bought by forest industries, the fourth largest consumer of purchased energy.

From this research and earlier studies, scientists have concluded that using forest residues as an energy source can have national impact in solving the forest industry's energy needs.







Prototype hydraulic wood chip pipeline.

### Moving Wood Chips by Pipeline

More complete and efficient utilization of forest and mill residues is often hampered and sometimes prohibited by the high cost of transporting wood chips.

To help alleviate this problem, researchers at the Intermountain Station and Montana State University have developed a system for transporting wood chips by hydraulic pipeline. The research took into account design and performance of pumps, injection systems, metering and flow-controlling devices, and other components of an operating pipeline. Results show that use of the pipeline system can cut transport cost in half.

The system can move chips from sawmills and plywood mills, where the chips are a byproduct, to a pulpmill or port. Other promising applications include moving chipped wood from chipping operations in remote forest areas where roads are inadequate. In areas where the chips could be transported by pipeline to a lower location, as in most western forest operations, the system operates by gravity flow, without conventional energy sources.

The hydraulic pipeline concept can be applied widely, regardless of distance, terrain, or weather. The concept is also energy efficient—pipeline transportation uses approximately one-eighth the energy required to move the same pulp tonnage by truck.

The hydraulic pipeline has drawn the interest of wood-based industries both in the United States and abroad.

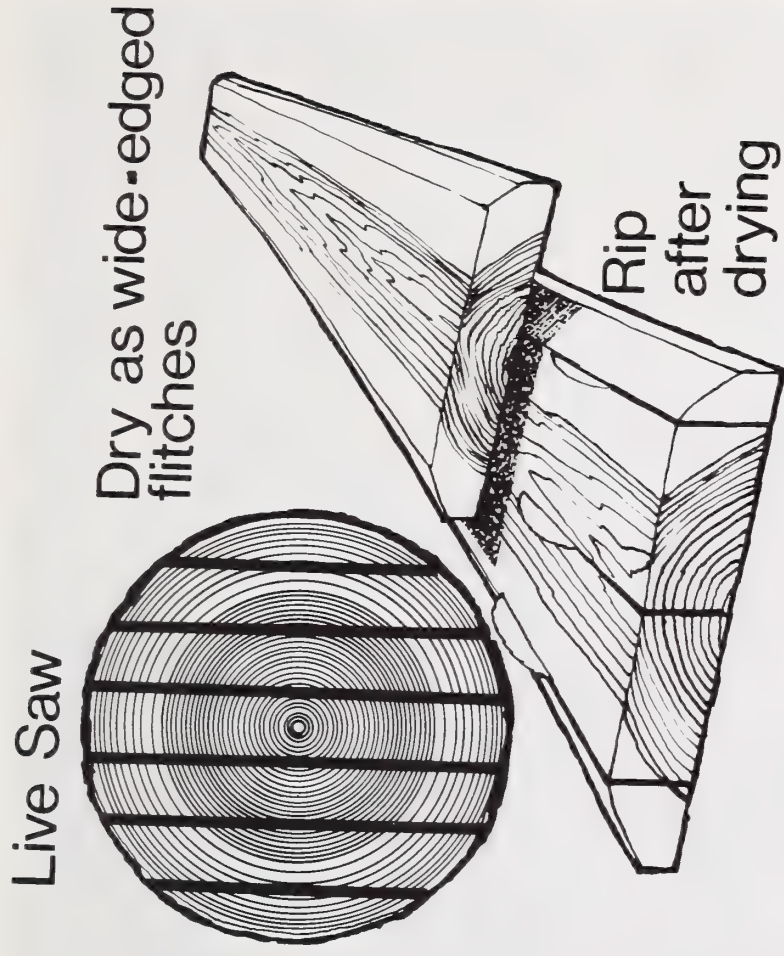
## Preventing Warp in Yellow-Poplar Studs

Yellow-poplar, underutilized in recent years, is now showing a surplus of small sawlogs. Although the species is ideally suited for studs because of its strength, small knots, and good nailing qualities, it has one serious fault: when sawed the conventional way, it warps badly.

Researchers at the Forest Products Laboratory have developed a processing system for hardwoods such as yellow-poplar that solves the warping problem. Dubbed the SDR (saw, dry, and rip) concept, the system utilizes old techniques, but in new ways.

SDR involves sawing logs into wide timbers (flitches), drying the flitches at high temperature (over 212° F), then ripping them into studs. More than 99 percent of the studs so manufactured met requirements for stud grade.

Initial research using yellow-poplar has shown a nearly 90-percent reduction in crook (the most critical warp factor) over conventionally sawn and dried studs. Utilizing yellow-poplar for studs can help to balance supply and demand for this species, reduce the current heavy drain on the softwood crop, and reduce the energy needs for transporting softwoods from West to East.







## New Wood Products Pass User Test

Forest Service research helps in the development of wood products that will best utilize the Nation's forest resources. COM-PLY, developed at the Southeastern Station, and PRESS-LAM, developed at the Forest Products Laboratory, are examples of recent successes. In the last year, both received the sternest test of a new product—use in practical situations. Both passed with high grades.

COM-PLY panels, studs, and joists were developed for building construction with the idea of extending the Nation's wood supply. Almost all the wood in a typical southern pine stand can be used in the manufacture of these products, whereas only about half the wood can be converted into conventional lumber and plywood. Research had shown that COM-PLY products—"sandwich" materials consisting of plywood and particleboard—are structurally safe, durable, dimensionally stable, and economical to manufacture. The question was whether building contractors would like them.

In 1978, a COM-PLY demonstration house was constructed near Atlanta to introduce the new products to builders in the Southeast. The people who built the house were particularly pleased with the straightness of COM-PLY studs and joists, and with the availability of extra long joists. They reported less waste and greater dimensional stability after heavy rains soaked the partially completed house.

Meanwhile, PRESS-LAM bridge stringers and decking are proving their value each day as cars and trucks cross Stony Creek in the George Washington National Forest in Virginia. PRESS-LAM products are made by gluing together sheets of veneer made from low-quality logs. They can be produced as long and as thick as necessary, and are far stronger than solid wood components of similar size.



PRESS-LAM is strong, fairly low in cost, and easily treated with preservatives—ideal for bridge components. The market for such material could be large: The Federal Highway Administration estimates that more than 100,000 small bridges currently need replacing in the United States alone.

## Way Paved for Greater Utilization of Tropical Forests

Segregation of tropical species is not necessary for manufacture of a wide range of wood-based products including hardboards, particleboards, and paper. All these products were made successfully at the Forest Products Laboratory from run-of-the-woods mixtures of species obtained from three different tropical areas of the world.

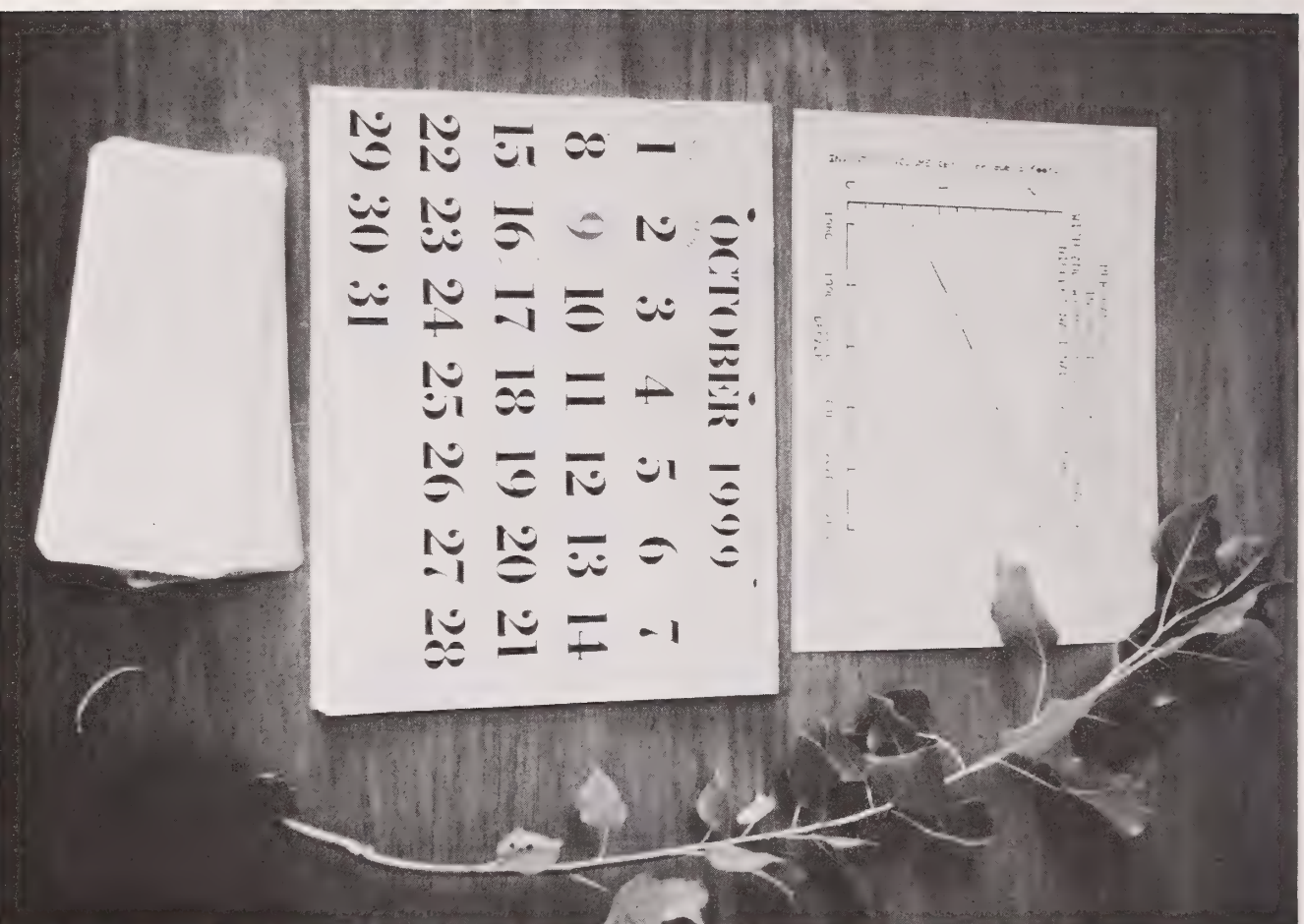
Advantages to using mixed tropical species are great. In the source countries, new jobs and higher living standards could result. In this country, because more forest products would be available, the balance of payments might benefit from lower prices.

The research, carried on in cooperation with the Agency for International Development, showed also that the tropical woods require less energy to process than do native species used for hardboard production. And finally, using all species of trees that the land produces permits leaving more of the forest in its natural state.

Current market prices do not warrant establishing a new pulpmill to produce kraft paper from mixed tropical hardwoods at this time. However, economists believe that by 1990 demand in Japan and Western Europe could create a market for imported tropical pulps. Certainly, as populations grow and the resource base shrinks, more complete utilization of tropical forests will occur.







## Computerized Crystal Ball

Foresters are always talking to themselves: What would happen if...? How can we be sure that...? Their problem is that they are dealing with nature's most long-lived organisms—trees—and so their decisions must reach a long way into the future. They're getting some new help now, though, from that seemingly universal tool—the computer.

Scientists at the North Central Station have developed a computer system that predicts tree growth in Lake States forests. Using data from a sample plot of trees, growth projections over 5, 10, even 100 years can be made for different silvicultural treatments and conditions.

Forest managers can now estimate the volume of timber that would be available under various management strategies for the next few decades. They can evaluate responses to thinning, harvest cutting, and other cultural treatments.

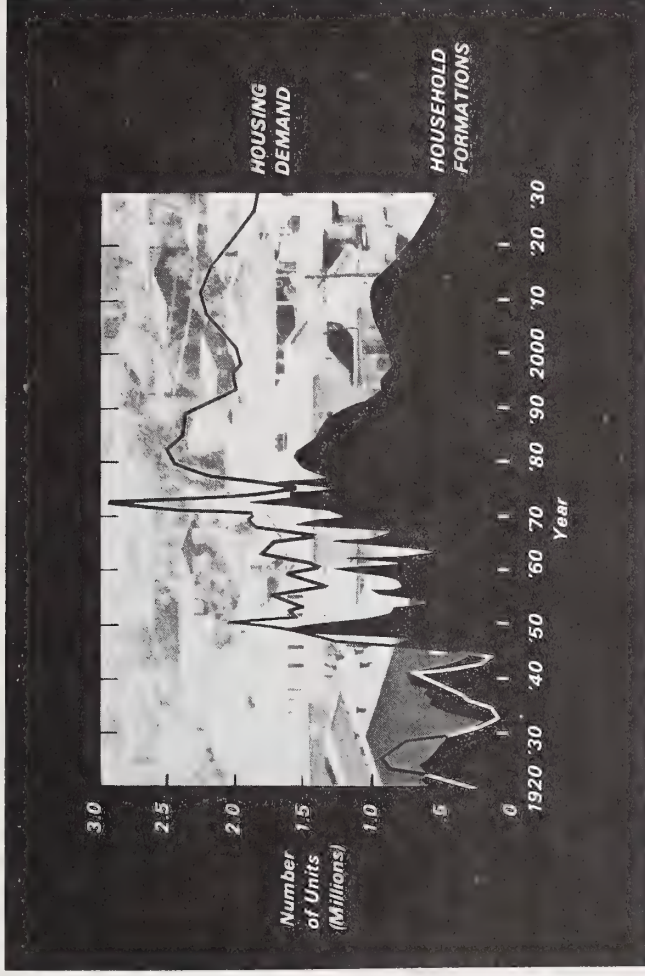
Researchers are now working to adapt this system to other regions of the country.

## Housing Demand Projected

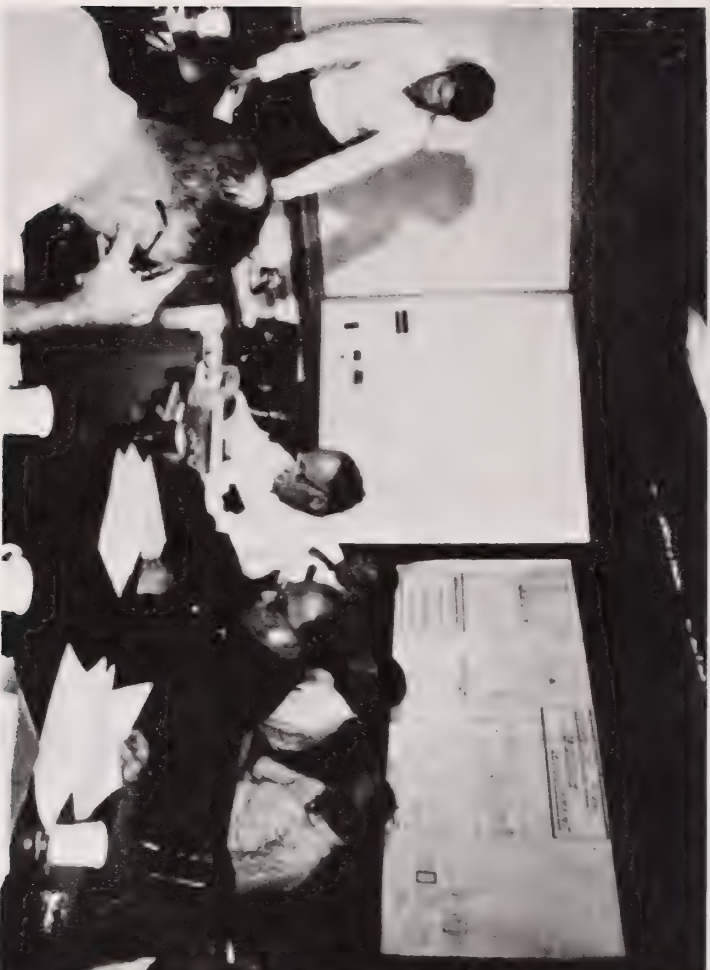
Housing demand will remain strong throughout the 1980's if economic growth continues, according to a projection model developed by researchers at the Forest Products Laboratory. After 1990, however, housing demand will moderate because of declining population growth. Demand for single-family housing will continue because of a predominantly middle-aged population. Shifts in population to the South and West are likely to continue, disproportionately increasing demand in these regions.

The model is proving especially helpful in estimating future timber requirements for the 1980 Resources Planning Act assessment and for use in planning by public and private businesses. The model was used by Oak Ridge National Laboratory to help develop a national residential energy-use model.

Projections of housing demand by type of unit and region to the year 2020 were published. These projections have been republished in part by several private groups. They have also formed the basis for estimating rural housing demand to 1985.







### **Help for Land-Use Planners**

Local forest and rangeland planning will be a major challenge for public land managers in the years ahead. Congress has directed the public land management agencies to improve their planning processes, and to provide better opportunities for interested citizens to help resource managers make wise decisions.

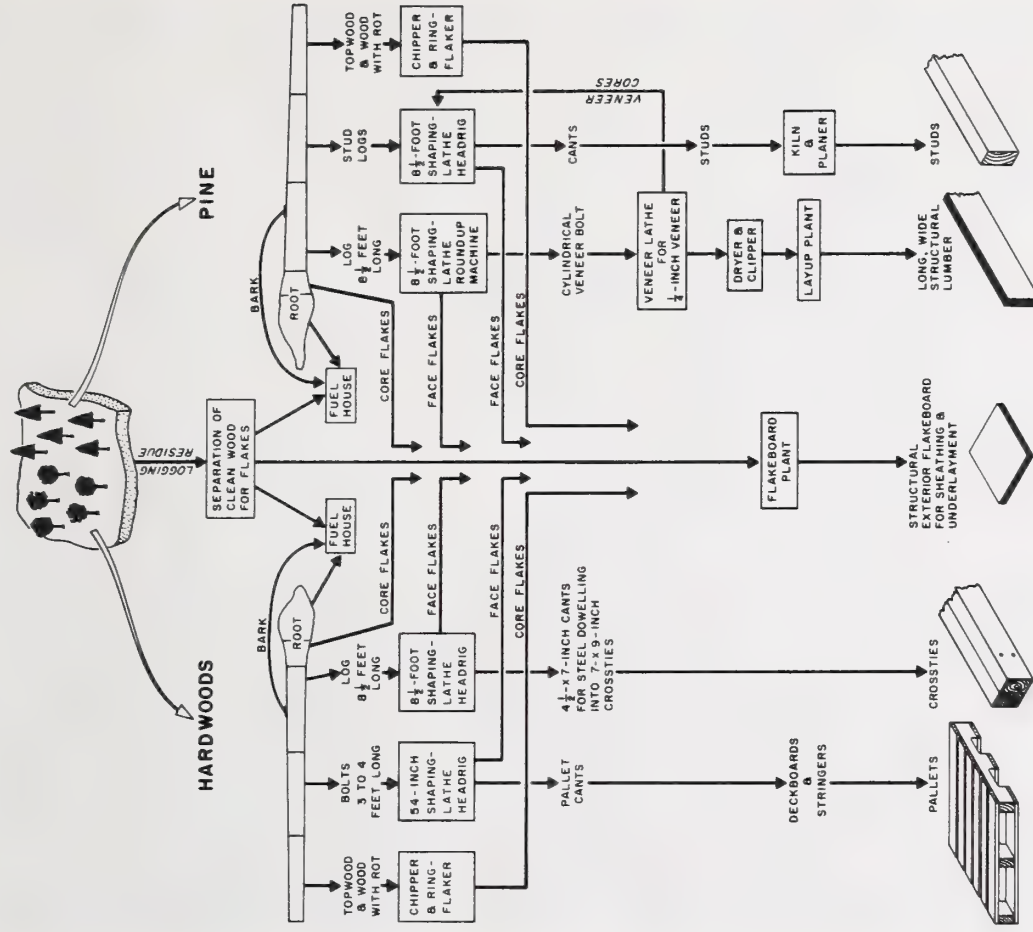
Rocky Mountain Station researchers in Arizona have improved ways of evaluating and displaying how alternative management decisions will affect yields of renewable resources: timber, water, forage for livestock and wildlife, and recreation opportunities. Visual displays of how resources are affected will make it easier for both interested citizens and land managers to evaluate the complex interactions among resources and the consequences of alternative decisions.

## Double Yield From Southern Pine?

Incomplete use of the resource has traditionally been a problem in forestry. As late as 15 years ago, only about 30 percent of the above—and below—ground portions of southern pine trees harvested for lumber was actually used. And low-grade hardwoods were not used at all. Since then the Southern Station has developed an integrated harvesting and utilization system that could more than double the production of salable wood from each acre of land harvested. Called BRUSH (Biomass Recovery and Utilization with Shaping-Lathe Headrigs), the system could recover two-thirds of the biomass of all tree species as solid wood products.

The system is built around a number of key machines invented or developed by Station scientists. These include: the shaping-lathe headrig for producing flakes and cants from pine and hardwood logs or bolts; the tree-puller to harvest trees with the taproot intact; the mobile-chipper to harvest residues and convert them to chips for fuel and fiber; the continuous tunnel kiln to produce straight, dry pine studs in 10 hours; and the suspension burner for direct-firing the kiln using green chips or bark as fuel. The products of this system are crossties, pallets, studs, structural exterior flakeboard that can compete with sheathing grades of plywood, and structural pine lumber in any desired length or width laminated from 1/4-inch veneer.

The system is operational and could be in widespread use in less than 10 years.







## Handbooks for Forest Managers

Growing a forest demands a lot of things: reproducing or planting a new stand, protecting it against insects and disease, nurturing its development, and harvesting its products. To do these jobs skillfully, the forest manager must have on hand the most current technical information.

He now has it—in a series of new handbooks that provide the latest and best information on eight tree species or groups of species common to north central forests. Scientists from the North Central Station have combined their silvicultural knowledge with the research and experience of others into convenient guides for onsite use. All the handbooks have a similar format, highlighted by a “Key to Recommendations” that can lead the forest manager to the silvicultural treatments prescribed for his particular stand of trees.

Although they deal primarily with timber production, these handbooks also suggest ways of modifying management practices to enhance recreation, wildlife, water, and other forest values.

Separate handbooks are available for four northern conifers—jack pine, red pine, black spruce, and white-cedar—and four hardwoods (or groups of hardwoods)—aspen, black walnut, northern hardwoods, and oaks.



## Management Guide for Allegheny Hardwoods

Many guides have been developed to aid foresters in judging how well a stand is stocked.

Researchers from the Northeastern Station have developed a new guide for Allegheny hardwoods describing maximum stocking to be expected in undisturbed stands and the minimum stocking needed for full yield in mixtures of black cherry, red maple, sugar maple, beech, white ash, birch, and other species. This guide incorporates for the first time a measure of the widely different growing space requirements of the various species that comprise this complex forest.

This information will permit accurate evaluation of Allegheny hardwood stocking and will provide a sound basis for determining minimum densities to leave after thinning or selection cutting.







### Test-Tube Trees for Hawaii

Not to be outdone by the recent test-tube baby, scientists at the Pacific Southwest Station have produced a clone of test-tube trees by propagating koa through "tissue culture." Koa is a valuable timber tree in Hawaii. Unfortunately, straight-stemmed, fast-growing superior trees are becoming rare, and the species is difficult to propagate by cuttings or other conventional methods.

From a single line of callous tissue—capable of cell division and root formation—the scientists produced hundreds of shoots, which continue to proliferate. They worked out a process by which the shoots were made to root and eventually grow in the nursery into healthy young trees.

Nursery-grown trees from the clone have been successfully established in field plantations, where they have attained normal form and growth rate. While tissue or single-cell cloning of other plants is somewhat more common, the techniques have been proved successful with perhaps no more than a half dozen tree species.

Tissue propagation ensures that all the young plants will be genetically identical to the parent tree. Each rooted plantlet continues to produce numerous shoots, which can be separated and grown independently to increase the clone.

Once established, tissue culture will produce young trees much more rapidly, less expensively, and in far less space than is required for vegetative cuttings from 5- or 6-year-old trees.

By selecting superior koa trees and cloning them through tissue culture, the scientists will provide growing stock that will greatly improve the quality of managed forests in Hawaii.

## New Nurse Tree for Walnut

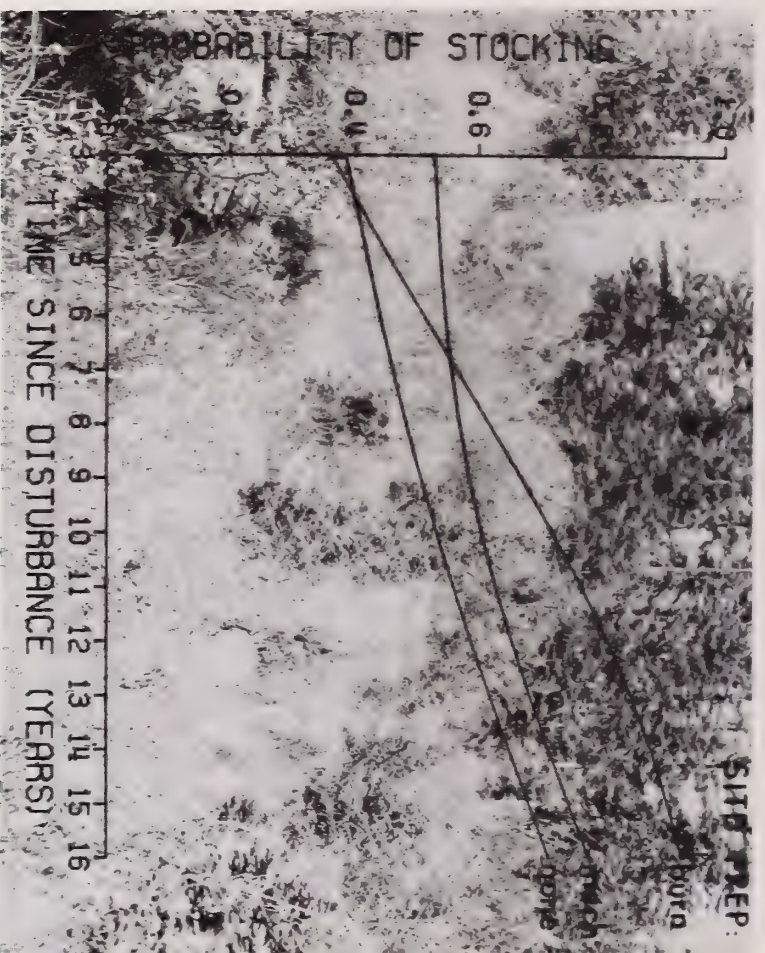
Sometimes even a sturdy-looking thing like a tree needs some help in growing. Often, that help comes from minute bacteria living in nodules on the roots of other plants. These bacteria change nitrogen from a gas into a usable form that all living things need—including black walnut trees.

Researchers from the North Central Station have found that they can use nitrogen-fixing plants, such as autumn-olive, to boost the growth of black walnut trees. On poor sites, young walnut trees may stagnate—stop growing—from lack of nitrogen before they are 10 years old. By planting walnut in mixture with autumn-olive, scientists have overcome this stagnation without resorting to fertilization. In plantations in Missouri, Indiana, and Illinois, walnut grown in mixture with this “nurse” tree averaged 82 percent taller than those in pure stands.



Rows of nitrogen-fixing autumn-olive “nurse” black walnut trees.





## Models Now Predict Forest Development

Intensive forest management depends on how well managers can predict future stand development. Timber harvesting is scheduled and management dollars are allocated according to such predictions.

Forest managers now have a valuable tool—sophisticated computer models—to accurately predict growth and yield of mixed forest stands. The rate of regeneration, after such practices as planting, site preparation, or partial cutting, can be forecast through use of the models. Thus, the manager can select a combination of cutting practices or regeneration methods that will be best for each location. Potential problem areas can be identified, and research and management efforts can be directed to increasing the productivity of such sites.

The models, developed by the Intermountain Station, are now being used by managers of public and some industrial land. Most of the National Forests in northern Idaho and Montana are incorporating the methods in their forest inventory and land management planning activities.



## Good Forestry Pays Dividends

Foresters consistently say that the future demand for timber can easily be met if private landowners will just apply simple forestry practices. These practices cost money—how good are they as investments?

In the Southern United States they are often attractive, according to analyses recently completed. If a 3 percent annual increase in stumpage price is projected, rates of return exceed 10 percent per year for various forms of tree planting and timber stand improvement on sites of moderate to high productivity. And these are what economists call “real rates”—effects of inflation have been removed. Rates of return and acreages that could be treated have not yet been compiled for the rest of the Nation, but they soon will be. It is all part of a national effort by the Forest Service, the Forest Productivity Committee of the Forest Industries Council, and a host of cooperators.

Computation of rates of return is the last and probably the easiest step in a difficult process that is nearing completion in the Nation's 26 largest timber producing States. Regional panels listed specific treatments that appear desirable, and the Forest Service estimated how much land in each State could benefit from each treatment. Public, forest industry, and other private lands were tested separately. Forestry experts from industry, government, and universities in each State estimated costs of treatments and increases in yield attributable to the treatments.

The result will be the first realistic nationwide assessment of opportunities to increase timber supplies through public and private investment. National figures will be published by the Forest Service in the Resources Planning Act Assessment, and figures for individual States will be published by the Forest Industries Council.







## Site Evaluation for Southern Hardwoods Made Easy

Soil scientists at the Southern Station have devised an accurate method for determining suitability of sites for eight of the most important hardwood species planted in the South. The method, recently published as a field guide, enables forest managers to assign numerical site index ratings to any soil or site in the southern hardwood region, except in mountainous areas.

One of the best features of the new technique is that it is easy to use. In fact, it doesn't even require knowing the soil series. And, it provides guidelines for improving the soil. For cottonwood, the leading plantation hardwood in the South, the method can be used to estimate volume production at various ages.

The approach is based on the fact that each of four major soil factors (physical condition, moisture, nutrient availability, and aeration) accounts for a certain proportion of tree growth. By examining each property of a soil and deciding whether it is good, adequate, or bad for a particular species, one arrives at a site-quality rating.

Field testing was only recently completed, but the method is already widely used across the South. Forestry interests have requested expansion to include additional species, and work has begun to add five more important hardwoods.

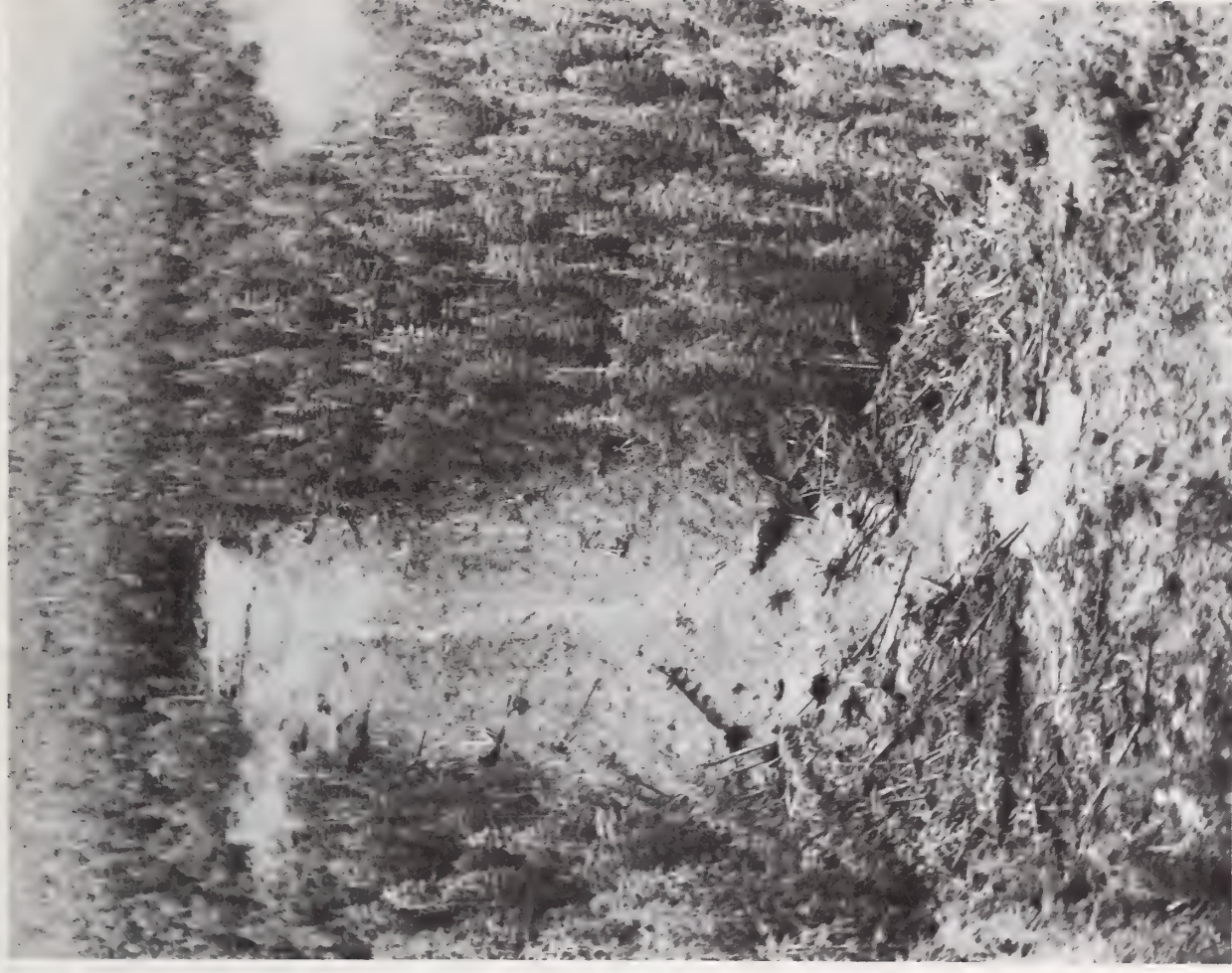


## Predicting and Preventing Landslides

A 5-year research program has revealed much about the cause and prevention of landslides in the Pacific Northwest. Scientists from the Pacific Northwest, Pacific Southwest, and Intermountain Stations have made progress in defining the mechanics of land failure and quantifying the contributing factors, and have begun to develop practical methods to identify potential problem areas.

Preliminary findings indicate that soil is strengthened by the intertwinning and anchoring of root structures. The effect of timber harvest practices on development of landslides has been defined and is being quantified for specific areas. In addition, researchers now know how much rainfall will cause soil to move on slopes, the effect of bedrock types and structure on the generation of landslides, and the type of landslide caused by major storms.

The program is now moving into a second stage with emphasis on applying research results in managed forests. A 5-year program has begun in southeast Alaska to (a) develop techniques for predicting landslide hazard resulting from forest management activities, (b) identify moisture conditions and storm characteristics that could trigger landslides under different geomorphic and geologic conditions, and (c) measure onsite and downstream landslide damage to water quality and anadromous fish habitat. The techniques developed are expected to be applicable throughout the Pacific Northwest.







## Impact of Roadless Areas on Timber Harvest

If money that might be spent to build roads into roadless areas of the National Forests were used instead for intensive management of timber on accessible lands, could timber harvest be maintained? The suggestion that as much—or more—timber might be produced with such a reallocation of funds prompted the Forest Service to look for answers to this question on seven western National Forests.

The answer—if all roadless areas on the study forests were withdrawn from timber production—is definitely *no*. Researchers found that lack of money for intensive management is not the only factor limiting the amount of timber that can be grown and harvested. The growing capacity of the land, under current restraints to provide for multiple uses of the forests, has been reached on many areas, and spending additional money would not result in increased production. If only half of the roadless areas were withdrawn, one of the study forests could produce the same amount of timber.

Researchers also compared the timber harvests that would be possible under such a reallocation of funds with average harvests of the past 10 years. They found that with all roadless areas withdrawn, recent levels could be continued on two of the seven forests; with half the roadless areas withdrawn, recent levels could be continued on six forests.



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